

from on high," from *temetzlli*, lead, and *piloa*, to fasten something high up. Lead was not unknown to the Aztecs before the conquest. They collected it in the Provinces of Tlachco and Itzmiquilpan, but did not esteem it of much value, and their first knowledge of it as a plummet must have been when they saw it in the hands of the Spaniards. Hence their knowledge of the instrument itself could not have been earlier.

The conclusions to which the above facts tend are as follows :

1. In the Maya system of lineal measures, foot, hand, and body measures were nearly equally prominent, but the foot unit was the customary standard.

2. In the Cakchiquel system hand and body measures were almost exclusively used, and of these, those of the hand prevailed.

3. In the Aztec system, body measurements were unimportant, hand and arm measures held a secondary position, while the foot measure was adopted as the official and obligatory standard both in commerce and architecture.

4. The Aztec terms for their lineal standard being apparently of Maya origin, suggest that their standard was derived from that nation.

5. Neither of the three nations was acquainted with a system of estimation by weight, nor with the use of the plumb-line, nor with an accurate measure of long distances.

An Experiment in Weather Forecast. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, Jan. 16, 1885.)

The class of '88, in Haverford College, have studied Chase's Elements of Meteorology, with a special view to the formation of trained habits of observation. They have acquired such skill in local weather forecast* that they undertook, early in December, to predict the probable regions of fair and stormy weather for all parts of the United States, on Christmas and New Year's days. The predictions were forwarded to Washington and submitted, through the courtesy of Gen. W. B. Hazen, Chief Signal

*The verifications, after two months' study, ranged between 74 and 90.3 per cent, the general average being 81.5 per cent.

Officer U. S. A., to the Board of Indications, to ascertain the degree of accuracy.

The following were the grounds of forecast :

1. The mechanical influence of solar and lunar tides on atmospheric currents, which has been tested by sixteen years' investigation and observations at Philadelphia and Haverford College. The normal tendency of tidal pressure, independent of friction, polar and equatorial currents and other disturbing influences, is from the East at syzygy, from the South at the following octant, from the West at quadrature, and from the North at the following octant, thus forming a lunar wind-rose, of a like character to Dove's solar wind-rose.

2. The normal percentage of average lunar rainfall on the several days of the lunar month, as deduced from three years' observations of the Signal Service Sergeants (Proc. Amer. Phil. Soc. xiv, 416-8).

3. The Signal Service tables of the winds which are most likely, as well as of those which are least likely, to be followed by rain or snow in each region, during each month of the year.

I had previously stated (Elements of Meteorology, Part i, p. 95), that "a verification of lunar forecasts in five cases out of nine should be regarded as satisfactory. In favorable localities, if due regard is paid to "temporary local influences, predictions may often be made for a month "in advance, which will prove true in three cases out of four." The reports which were received from the Signal Office were examined in several different ways, the lowest mean verification of lunar influence for the two days being 59 per cent., while the highest was 100 per cent., as is shown by the following tests :

I. Tests of Lunar Influence.

a. The tri-daily bulletins of the Signal Service Bureau, show that in 13 of the 22 regions, or 59.1 per cent., there were such differences of barometric pressure between the two days of observation as should be produced by tidal influence, viz : increased pressure when the normal currents are retarded, diminished pressure when they are accelerated.

β. The normal relation of temperature to pressure (thermometer rising when barometer falls, and *vice versa*) was shown in 17 of the 22 regions, or 77 per cent.

γ. The tendency to partial reversal of surface currents by friction, in passing over the land, and consequent partial opposition of lunar influence,* was shown in 19 of the 22 regions, or 86 per cent.

δ. The rainfall on Christmas day was 1.07 times as great as that upon New Year's day. The lunar normal ratio was 1.04. This represents a verification of 97 per cent.

ε. The influence of "favorable localities," independent of any regard to "temporary local influences," was shown in the Middle Atlantic States,

* Elements of Meteorol. Part i, pp. 93-5, Par. 1, 8; Proc. Amer. Phil. Soc., xi, 113.

where the verification was 100 per cent., the weather at every station, on each of the days, being such as was foretold.

II. *Tests of Solar Influence.*

ζ. The special report of the Board of Indications, showed a verification of 70.7 per cent. for the fair forecasts and a rainfall, in amounts sufficient to be measured, in 25 per cent. of the regions for which stormy indications were foretold. The full significance of this test cannot be satisfactorily determined, because the normal proportion of stormy winds which bring actual rainfall has never been published.

η. The forecasts which were authorized by the Signal Service tables showed a verification of $1275 \div 19 = 67.1$ per cent. on Christmas day, and of $575 \div 15 = 38.5$ per cent. on New Year's Day, or a general mean of $1850 \div 34 = 54.4$ per cent. In three of the regions at the former date, and in seven at the latter, no forecasts were prescribed by the tables, the wind-deflecting tendencies being from doubtful azimuths. This test, like the foregoing, is affected by the uncertainty as to what constitutes a satisfactory verification of storm-forecasts which cover winds from one-half of the azimuths.

θ. As nearly as could be ascertained from the tri-daily reports, the stormy indications in the Signal Service tables were verified in 65 per cent. for the fair winds, and there was measurable precipitation after 43 per cent. of the stormy winds, the general mean verification being 60 per cent. This would indicate a verification, according to the preceding test, of $54.4 \div 60 = 90.7$ per cent.

ι. The ratio of lunar to solar monsoon influence, which was shown in tests α and η ($59.1 \div 54.4 = 1.086$) agrees very nearly with the ratio which was shown by the winds at Haverford during the past year ($545 \div 514 = 1.06$). Of 1059 observations, 545 were nearer the azimuth which represented the lunar tidal tendency and 514 nearer that which represented the solar monsoon influence, as given by Coffin (*Winds of the Globe*, p. 431). This degree of accordance seems to justify the belief that the subsidiary value of lunar normals would be found as great elsewhere as it is at Haverford, for detecting and coördinating the abnormal influences of equatorial or polar, cyclonic or anticyclonic, local or general currents.

III. *Tests at Haverford College for 1884.*

κ. Tidal acceleration of atmospheric currents was accompanied by low barometer; tidal retardation by high barometer.

λ. The percentage, both of stormy winds and of cloudiness, was greater in the lunar stormy cycles than in the fair cycles.

μ. Of the 120 days on which the lunar tidal tendencies were more stormy than fair, 54 were accompanied by measurable precipitation; on 32 other days there were winds from stormy directions; 11 others were

cloudy, and on 23 days no special evidence of stormy disturbance was recorded. This represents 81 per cent. of verification by storm or stormy tendency, and 19 per cent. of failure.

ν. Of the 120 days on which the lunar tidal tendencies were more fair than stormy, 74 were fair; on 21 other days there were winds from fair directions, and on 25 days there was rain or snow with no special record of fair influence. This represents 62 per cent. of complete verification, 17 per cent. of partial verification, and 21 per cent. of failure.

ξ. Making allowance for one day's possible shifting of fair and stormy tendencies, by the acceleration of equatorial cyclonic currents, or the retardation of polar anticyclonic currents, 85 per cent. of the fair, 71 per cent. of the stormy, and 79 per cent. of all the indications were completely verified. In this test no stormy verification was admitted in which there was not an actual measurable amount of rain or snow.

ο. Of the winds from stormy quarters during the year, 63 per cent. were followed within 24 hours by measurable amounts of rain or snow. Of the winds from fair quarters, 72 per cent. were followed by fair weather for 24 hours, with no measurable amount of rain or snow. The mean verification of all the wind indications was 68 per cent.

π. The comparative value of forecasts, from lunar indications which might have been foretold years in advance, and from wind indications which are good only for a day in advance, was $45 \div 63 = 71.4$ per cent. for storm; $62 \div 72 = 86.1$ per cent. for fair; $53 \div 68 = 77.9$ per cent. for all.

ρ. The percentage of verification for stormy indications was greatest in winter and least in summer.

σ. The percentage of verification for fair indications was greatest in autumn, and least in winter. There were marked indications, however, of a tendency toward general maximum verification in summer.

τ. The percentage of total verification was greatest in winter, when the thermal disturbance of Moon's tidal action is least, and least in summer, when the thermal disturbance is greatest.

υ. The percentage of verification, both for the fair and for the stormy indications, was greater in the equinoctial semester than in the solstitial.

φ. The conflict of solar daily and monsoon influences with lunar monthly tidal influences was shown in numerous cases of stormy anti-cyclonism and fair cyclonism which had been overlooked in the daily forecasts from Washington. Predominating solar influence accounted for 32 of the 46 abnormal days during the fair lunar tendencies, and 51 of the 66 abnormal days during the stormy lunar tendencies, or 74 per cent. of the whole.

It would be unwise to draw any positive conclusions from the results of a single experiment, or from observations for a single year at a single station, but there is certainly encouragement for continuing the line of investigation which is here indicated.

⋮